

A chapter from

Adaptation of Chickpea in the West Asia and North Africa Region

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6.1. Future Research Priorities for Chickpea in WANA and SAT

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An objective assessment of the needs and opportunities in chickpea research is essential for formulating plans so that the productivity of the crop is sustained in all chickpea-growing regions, especially of the WANA region. To achieve this objective, information on different aspects of chickpea production has been analyzed and documented in the first five chapters of this book. These chapters also cover the status of the crop in 11 important chickpea-growing countries in WANA. An interpretative regional summary of biotic, abiotic, and socioeconomic constraints to chickpea production in the three WANA regions—West Asia (Section 2.6), North Africa (Section 3.4), and Nile Valley countries (Section 4.4)—and across the WANA and SAT regions (Chapter 5) has been presented. A similar study of chickpea production in South Asian countries was undertaken earlier by Virmani et al. (1991). In this chapter, we will evaluate the need for continued research on the crop and suggest future areas of research thrust.

Role of Chickpea in Agricultural Production Systems

Due to the increasing need for legumes, chickpea is no longer considered a subsistence crop. The upward trend in its trade (Section 5.8)

suggests that the crop is grown increasingly for the market. Our study contests the general belief that increasing use of input responsive crops (particularly wheat) has relegated chickpea to marginal lands in the WANA region. Although the area and production of chickpea has decreased to some extent, its productivity and imports have been steadily going up (Section 5.8). Chickpea is now mostly cultivated as a sole crop in several countries.

Research Needs and Opportunities

The available statistics on chickpea area, production, yield, price, and trade (Section 5.8) show that in most of the countries studied (Chapters 2, 3, and 4), the demand for the crop is greater than the supply. It is predicted that this trend will continue in the near future. Yet, it is surprising that even though a favorable economic environment exists, there has not been a large-scale expansion in chickpea cultivation and production in areas where the crop is habitually grown, except in Turkey and Australia. This apparent contradiction reflects a gap in our understanding of farmers' needs. We have to identify urgently and correctly their needs and transfer to them appropriate technologies to overcome constraints at the farm level.

Demand and Uses of Chickpea

Demand for a crop is generated by the diversity of its uses. Chickpea is consumed in different ways (Jambunathan 1991), generally with cereals (wheat and rice). There are many other uses of chickpea such as in snacks and sweets. It is also used as livestock and poultry feed, but increasing prices have discouraged this use. There are a few reports on the commercial use of the crop in the preparation of baby food, starch, and in plywood industries. Demand, for chickpea therefore, seems to be primarily driven by its use as a food crop.

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Profitability of Chickpea Cultivation

The declining chickpea area and production, in spite of increasing demand, suggests that it may not be profitable to grow the crop in the prevailing production systems, because:

- improved technologies (varieties and management practices) either have not reached the farmers, or else
- farmers do not find them useful under their management conditions.

Research has shown that it is more profitable to grow chickpea than cereals and other nonlegumes in rainfed agriculture, because of its low dependence on expensive inputs (NP fertilizers) (Section 1.4). In the traditional chickpea-growing areas, e.g., in South Asia, the water requirement of the crop is low, due to the low evaporative demand of the atmosphere during the chickpea-growing season. Also, the cost of labor is generally low in the rainfed areas. These factors made chickpea a profitable crop in the past in low-input rainfed production systems. In many traditional chickpea-growing countries in WANA and SAT, this practice continued for many decades. Lately, however, irrigation and fertilizer, to which chickpea is not very responsive, are increasingly available. The cost of labor has also gone up coupled with increased disease incidence on chickpea. Due to these constraints, chickpea has lost its economic competitiveness vis-à-vis other crops in many countries and the area under it has consequently reduced.

Increasing demand for the crop in Turkey and Australia, however, has favored its expansion in these countries. In Turkey, where chickpea has been traditionally grown during spring, fallow lands have been replaced with spring-sown chickpea. In Australia, the crop was introduced in response to increasing demand from Asia. It is perhaps economical to grow the crop in Australia because of large-scale mechanized production.

Factors that determine productivity and profitability of chickpea depend upon the agroecological and socioeconomic environment in which it is produced. For example, in India (Section 5.8), a decrease in traditional chickpea-growing area (northern India) occurred due to lack of varieties responsive to high inputs. On the other hand, its cultivation increased in non-traditional areas in peninsular India (western and southern parts) due to the availability of irrigation in these warm subtropical environments. No radical change in production technology, chickpea varieties, or management technique, was involved in this large-scale area expansion in peninsular India. New areas where such opportunities exist or any improvements in existing technologies that would lead to the opening up of new opportunities need to be identified.

Factors that are important for boosting chickpea profitability in WANA are:

- Increase in productivity, and
- Reduction of production cost through
 - economic use of inputs, and
 - mechanization of field operations to reduce labor costs.

Increase in Productivity

Both genetic and agronomic options are available for enhancing yield and stability of chickpea production. In practice however, these are not two independent options but are components of an integrated crop management (ICM) strategy for increasing chickpea production.

Genetic options

Chickpea productivity can be increased through greater on-farm use of existing high-yielding genetic material. As past efforts for enhanc-

ing the genetic yield potential of chickpea have not been very rewarding (Saxena and Johansen 1990), the current emphasis in genetic enhancement research is mainly on the incorporation of resistance to known biotic and abiotic stresses.

Ranking of various biotic and abiotic constraints to chickpea production based on realistic estimates of yield losses, is a prerequisite for researchers and planners to set priorities and allocate resources in order to overcome these constraints. Such prioritization of biotic and abiotic constraints in cool-season food legumes, including chickpea, has been done on a global scale by Johansen et al. (1994). Similar prioritizing of constraints in national programs would be very useful.

Environmental stresses. Drought appears to be the most widespread constraint (Section 5.2; Johansen et al. 1994) because more than 90% of the world chickpea area is rainfed. Variations of inter- and intra-seasonal rainfall (quantity and distribution) in WANA and SAT are well documented. It is, however, a matter of great concern that drought has not been accorded a high priority in applied research. Methods to alleviate drought effects, through escape and resistance mechanisms, are now available (Section 5.2) and could be exploited on farm. Problems related to temperature (heat, cold, and frost) effects on chickpea production are region-specific. Salinity is important only in some countries, (e.g., Iran). It should be given a low priority in breeding programs as salinity-resistant germplasm material is not available.

Diseases. Diseases appear to be the most important constraint that causes yield instability (Section 5.3). Concerted efforts are needed for enhancing resistance to diseases. Fortunately, sources of resistance to many of the soilborne and foliar diseases are now available, including multiple disease-resistant material (Table 5.3.3 in Section 5.3). For such diseases as ascochyta blight (*Ascochyta rabiei*) and botrytis

gray mold (*Botrytis cinerea*), the resistance levels are low. Strategic research to increase levels of resistance through gene pyramiding is necessary. Instances of break-down of disease resistance (due to new races or pathotypes) are often reported. Durable resistance needs to be ensured in germplasm enhanced for disease resistance. Fusarium wilt (*Fusarium oxysporum*) is most widespread across the SAT and WANA regions. Most progress has been made in developing varieties with durable resistance to this disease. Yield losses caused by nematodes remain to be quantified. Progress in mapping the cyst nematode (*Heterodera ciceri*) (in WANA) by ICARDA and the root-knot nematode (*Pratylenchus* spp) (in SAT) by ICARISAT, and screening of germplasm should help in controlling these nematodes effectively.

Insect pests. Differences in insect pest importance (Section 5.4) between WANA—for leafminer (*Liriomyza cicerina*)—and SAT—for pod borer (*Helicoverpa* spp)—emphasize the regional differences in their distribution. *Callosobruchus* spp (stored grain pests) are common across WANA and SAT. Yield losses caused by various insect pests remain to be correctly estimated. Acceptable levels of resistance have not been found for any of these insect pests, but some genotypes with low levels of pest incidence have been identified.

Nutrient use and fertilizer economy. In recent years, research on biological nitrogen fixation (BNF) has helped to quantify its benefits to the nitrogen economy of the chickpea crop and the sustainability of production systems (Section 5.5). To enhance BNF benefits, it is necessary to identify high-nodulation material that increase yields, with tolerance for high soil nitrate levels to ensure an adequate symbiosis. Inoculation responses observed in WANA suggest large potential benefits of this cheap technology. Therefore, research on BNF needs to be strengthened in national programs. Interaction of BNF with drought and temperature suggests that screening of

genotypes for high BNF efficiency should be conducted in well-defined soil moisture requirements.

The efficiency with which chickpea can exploit soil P, even from sources not used by other crops including legumes (Ae et al. 1991), has not been fully recognized and exploited. Also, genotypic differences in utilization efficiency of soil P in chickpea have not been evaluated. Such differences, if they exist, would be useful in further enhancing the efficiency of this trait.

Quality considerations. Seed quality considerations (other than nutritional) are determined by the uses of chickpea, and differ from country to country (Chapters 2, 3, and 4; Jambunathan 1991; Pushpamma and Geervani 1987). Where chickpea is used as whole seed (as in WANA countries), seed size is an important quality trait. One of the reasons for the relatively low adoption of winter chickpea technology by farmers in Morocco, was the relatively small seed size of new varieties released for winter sowing (Section 5.7).

Agronomic options

No systematic study has been conducted on agronomic factors as constraints to chickpea production, except for competition due to weeds. Poor plant stand in farmers' fields and competition from weeds are often stated as major constraints to chickpea production. The effects of land preparation, conservation of rainfall for spring sowings in WANA, and chickpea grown in stored soil moisture conditions in South Asia, are difficult to assess in the absence of empirical databases.

Plant stand. Information on plant stands, correlated with biotic and abiotic constraints and factors of poor management, needs to be documented. Since chickpea is mostly grown as a rainfed crop, poor

plant stands in South Asia are often a result of inadequate soil moisture in the seedbed at the sowing time. Sowing methods which are effective in placing the seed at soil depths where adequate moisture is available, can overcome this constraint.

Matching crop duration to favorable soil moisture regimes.

In WANA, winter chickpea technology has proved effective in increasing chickpea yields through alleviation of severe terminal drought which occurs in spring-sown chickpeas (Sections 5.2 and 5.6). The technology holds great promise and is being popularized. In spite of the large demonstrated potential benefits of the technology, its adoption is slow. Certain components of this technology that are being modified (enhanced ascochyta blight resistance, frost tolerance, weed control, and increase in seed size) would give the required impetus to its large-scale adoption. Winter sowing will, however, not replace all the spring-sown chickpea (Section 2.6) and the emphasis on the improvement of yield and production practices of spring-sown chickpea needs to be continued. A comparable approach in warm subtropical environments of peninsular India was made, by advancing the sowing date to end-monsoon to alleviate drought effects in chickpea, but this did not prove to be a viable option (Section 5.2).

Limited irrigation. Although chickpea in WANA is grown as a rainfed crop, except in Egypt and Sudan (Section 3.4), large responses in grain yield are observed when two to three irrigations are applied in spring chickpea in WANA and in warm, subtropical conditions in peninsular India. In such areas, irrigation is becoming increasingly available and this would probably contribute to the expansion of chickpea area in the target region. Since there is little danger of foliar diseases, and chickpea cultivars resistant to soilborne diseases are already available, this may be a feasible option in the future.

Integrated crop management. The strategies of integrated pest management (IPM) and integrated disease management (IDM) focus on the management of a particular constraint, either a given disease or a pest. Even with varieties which are resistant to important diseases, appropriate agronomic management is essential for the expression of their true genetic yield potential. Thus, the introduction of integrated crop management (ICM) strategies which include components of improved seeds, agronomic management practices, and the IPM-and IDM-based measures should enhance yields and crop profitability.

Reduction of Production Cost

Economy and efficiency in the use of inputs

It should be possible to recommend need-based fertilizer application for chickpea. The crop has a high efficiency of meeting its N needs from BNF and P needs from soil P. It effectively uses residual fertilizers in cropping sequences. Such practices should enhance the profitability of chickpea production considerably. It is necessary to make the farmers aware of these benefits of chickpea cultivation.

Mechanization of operations

Increasing labor costs for agronomic operations has been listed as an important constraint to sustainable chickpea production across many WANA countries (Chapters 2, 3, and 4 and Section 5.6). It is also becoming an important constraint in some SAT countries. Therefore, mechanization of sowing and timely management of weeds in the early stages of crop growth is essential. Mechanized options for harvesting are now available (Section 5.6). Concerted efforts for their adoption by farmers will have a significant impact on chickpea production.

Recommended Thrust Areas of Research

The following thrust areas should be emphasized as they probably will have a significant impact on the increase in the area and production of chickpea in many countries.

- Delineation of production systems in which chickpea can be introduced on a large scale or in specific niches;
- Identification of factors that enhance profitability of chickpea cultivation in current production systems and in areas where the crop is newly introduced; and
- Strengthening of research capabilities of NARS in conducting applied research to overcome major biotic and abiotic constraints to chickpea production under their conditions.

Multidisciplinary Approach

The concept of an ICM strategy, which includes IDM and IPM as components of management practices, makes multidisciplinary teamwork inevitable. To make the various multidisciplinary working groups function smoothly and effectively, it is necessary to:

- Recognize the comparative strength of each partner in discharging a task;
- Involve all partners in developing workplans and review of progress;
- Define roles and responsibilities of members in a given working group; and
- Share resources and credits fairly within a working group.

Networks and Working Groups

Aggregation of constraints to chickpea production at higher levels—national, ecoregional, and global—have helped identify activities of common research interests. Increasing interaction between scientists

at regional and international fora have brought together research workers, who were earlier working in isolation through such networks and working groups as the Global Grain Legumes Drought Research Network (GGLDRN), Asia Working Group on Biological Nitrogen Fixation (AWGBNLF), Cereals and Legumes Asia Network (CLAN), etc. Participating scientists benefit from such collaboration through pooling of knowledge and resources, which allows a greater efficiency of utilization of available resources. The research objectives of each partner, individually and collectively, can be met through this framework. Coordination of such networks is important for enabling NARS to ensure effective implementation of workplans.

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